Decision Rationale

Total Maximum Daily Loads for
Fecal Coliform for Four Segments of Catoctin Creek

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDLs for fecal coliform for four segments of Catoctin Creek. EPA's rationale is based on the determination that the TMDLs meet the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDLs are designed to implement applicable water quality standards.
2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDLs consider the impacts of background pollutant contributions.
4) The TMDLs consider critical environmental conditions.
5) The TMDLs consider seasonal environmental variations.
6) The TMDLs include a margin of safety.
7) There is reasonable assurance that the TMDLs can be met.
8) The TMDLs have been subject to public participation.

II. Background

The 59,000 acre Catoctin Creek watershed is located in Loudoun County. The TMDL addresses the four impaired stream segments. Agricultural lands (67%) and forests (30%) make up roughly 97% of the 59,000 acre watershed. The four impaired segments are the North Fork of Catoctin Creek, the upper South Fork of Catoctin Creek, the lower South Fork of Catoctin Creek and Catoctin Creek. The impaired segment of the North Fork of Catoctin Creek is 10.53 miles in length beginning just less than a mile upstream of the Route 719 bridge near Hillsboro and terminating at its confluence with Catoctin Creek. The impaired segment of the lower South Fork of Catoctin Creek is 6.01 miles in length beginning approximately 0.5 miles upstream of the Route 9 bridge and terminating at its confluence with Catoctin Creek. The impaired segment of the upper South Fork of Catoctin

Creek begins a mile upstream of the Route 761 and Route 719 intersection and continues to its confluence with the lower South Fork of Catoctin Creek. The impaired segment of Catoctin Creek is 7.4 miles and begins at its confluence with Milltown Creek and continues to its confluence with the Potomac River.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed all of the above mentioned segments of Catoctin Creek with the exception of the upper South Fork of Catoctin Creek as being impaired by elevated levels of fecal coliform on Virginia's 1998 Section 303(d) list. These segments were listed for violations of Virginia's fecal coliform bacteria water quality standard. The upper South Fork of Catoctin Creek will be listed on Virginia's 2002 Section 303(d) list of impaired waters. Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA has been encouraging the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation has been drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth plans on adopting the e-coli and enterococci standards in late 2002.

As Virginia designates all of its waters for primary contact, all waters must meet the current fecal coliform standard for primary contact. Virginia's standard applies to all streams designated as primary contact for all flows. Through the development of these and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the fecal coliform standard. Thus, many of Virginia's TMDLs have called for some reduction in the amount of wildlife contributions to the impacted streams. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In the first phase of the implementation, the Commonwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that during Phase 2, it may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated as primary contact for infrequent bathing. The Commonwealth will also investigate incorporating a natural background condition for the bacteriological indicator.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary, as the violation level associated with the wildlife loading may be smaller than the percent error of the model or the MOS. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted.

The impaired segments of Catoctin Creek are identified as watershed VAN-A02R and were given a high priority for TMDL development. Section 303(d) of the CWA and its implementing regulations require a TMDL to be developed for those waterbodies identified as impaired by the state where technology-based and other controls do not provide for the attainment of water quality standards. The TMDLs submitted by Virginia are designed to determine the acceptable load of fecal coliform which can be delivered to each of the impaired segments of Catoctin Creek, as demonstrated by the Hydrologic Simulation Program Fortran (HSPF)[1], in order to ensure that the applicable water quality standards are attained and maintained. HSPF is considered an appropriate model to analyze these watersheds because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the HSPF model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to all of the complex spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.[2] Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform which is reaching the stream from land based sources. Point sources and wastes deposited directly to the stream were treated as direct deposits. These wastes do not need a transport mechanism to reach the stream. The allocation plan calls for the reduction in fecal coliform wastes delivered by cattle in-stream, wildlife in-stream and straight pipes.

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[1]Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

[2]CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia,

Table 1 - Summarizes the Specific Elements of these TMDLs.

Segment	TMDL	WLA (cfu/yr)	LA (cfu/yr)	MOS (cfu/yr) [1]
Upper South Fork Catoctin Creek	1.06E+14	4.42E+11	1.03E+14	2.64E+12
Lower South Fork Catoctin Creek	9.34E+14	1.60E+11	9.30E+14	3.92E+12
North Fork Catoctin Creek	3.30E+14	0.0	3.27E+14	2.69E+12
Catoctin Creek	8.56E+14	0.0	8.44E+14	1.08E+12

1 Virginia includes an explicit MOS by identifying the TMDL target as achieving the total fecal coliform water quality concentration of 190 cfu/100ml as opposed to the WQS of 200 cfu/ml. This can be viewed explicitly as a 5% MOS.

EPA believes it is important to recognize the conceptual difference among the waste load allocation (WLA) values, load allocation (LA) values for sources modeled as direct deposition to stream segments, and LA values for flux sources of fecal coliform to land use categories. The WLA values and LA values for direct sources represent amounts of fecal coliform which are actually deposited into the stream segments. The HSPF model, which considers landscape processes which affect fecal coliform runoff from land uses, determines the amount of fecal coliform which reaches the stream segments. The LA in Table 1 is the amount of colony forming units (cfu) reaching the stream from nonpoint sources annually.

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing these fecal coliform TMDLs for the impaired segments of Catoctin Creek. EPA is therefore approving these TMDLs. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality standards and designated uses on the impaired segments of Catoctin Creek. The water quality criterion for fecal coliform is a geometric mean 200 cfu/100mL or an instantaneous standard of no more than 1,000 cfu/100ml. Two or more samples over a 30 day period are required for the geometric mean standard.

Since the state rarely collects more than one sample over a thirty-day period, most of the samples are measured against the instantaneous standard. The HSPF model provided the modelers with water quality samples at a fifteen minute time step, 2,880 samples for a thirty day month. Therefore, the TMDLs were designed to meet the geometric mean standard. The monitoring stations within the impaired segments of Catoctin Creek, with greater than 4 samples, had violation rates between 15 and 42%. It is important to note that these violations were based on the 1,000 cfu/100 mL instantaneous standard. Samples that were in accordance with this standard may still be above 200 cfu/100 mL and thus problematic for the attainment of the geometric mean. The geometric mean is designed to diminish the impact of a small number of extremely large samples on a data set. Therefore, the geometric mean is most impacted by the conditions that occur most often.

The HSPF model was used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from point and other direct deposit sources necessary to support the fecal coliform water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of fecal coliform to the impaired segments of Catoctin Creek will ensure that the applicable criterion is attained.

The TMDL modelers determined the fecal coliform production rates within the watershed. Information and data used in the models was obtained from a wide array of sources, including farm practices in the area, the amount and concentration of farm animals, point sources in the watershed, animal access to the stream, wildlife in the watershed, wildlife fecal production rates, land uses, weather, stream geometry, etc.. The model combined all the data to determine the hydrology and water quality of the stream.

Calibration is the process of comparing modeled data to observed data and making appropriate adjustments to model parameters to minimize the error between observed and simulated events.[3] The hydrologic portion of the models was calibrated to the United States Geological Survey gage #01638480 which is located within the watershed. Data was available from the gage from July 1971 through September 2000. The calibration period was from October 1990 through September 1995. This period was selected as representing the hydrology of the area and including the critical conditions associated with the watershed. Several parameters including the evapotranspiration rate, recession rates to groundwater and interflow, storage capacity within the subsurface and surface zones, slope, and forest cover were adjusted to insure that the calibration closely represented the observed data. The simulation slightly over-represented the observed data in several of the calibration field inspections (total annual runoff, total of highest 10% of the flows, etc.). However, the overall calibration fit the observed data within the established bounds.

[3]Maptech, 2002. Fecal Coliform TMDL Development for Catoctin Creek Impairments, Virginia. April 23, 2002.

In order to insure that the calibration is representing actual conditions properly, the model was transferred to a different time period and had run without adjusting the hydrologic parameters. For the impaired segments of Catoctin Creek, the model was validated against observed flow conditions from October 1995 through September 1999. Obviously, the model did not perform as well as it did during the calibration phase, however the model did meet the boundaries established for the validation with the exception of the lowest 50% of flows parameter. Please refer to the MapTech report for a visual comparison of the observed versus simulated flow data.

The model was then adjusted to include the loading of fecal coliform to the stream. The calibration for water quality criteria was conducted from January 1993 through December 1995. Four parameters within the model were adjusted to insure that the calibration represented observed conditions as closely as possible. The parameters were the first order decay rate, maximum accumulation of fecal coliform on land, the runoff needed to washoff 90% of the fecal coliform from land surfaces and fecal coliform concentration in subsurface zones. The calibration was evaluated against the instantaneous measurements collected by VADEQ. The water quality model was then validated in a similar manner as the hydrology. The validation was run against observed data from January 1998 through December 2000.

EPA believes that using HSPF to model and allocate fecal coliform will ensure that the designated uses and water quality standards will be attained and maintained for the impaired segments of Catoctin Creek.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading of fecal coliform is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest, commercial and services, residential, cropland, livestock operations, farmstead, unimproved pasture, improved pasture and potential livestock access), directly deposited nonpoint sources of fecal coliform (cattle in-stream, wildlife in-stream, lateral flow from septic systems located within 50 feet of the stream and straight pipes), and point sources. Activities such as the application of manure and the direct deposition of wastes from grazing animals are considered fluxes to the land use categories. The actual value for the total fecal load can be found in Table 1 of this document. The total allowable load is calculated on an annual basis due to the nature of HSPF model.

Waste Load Allocations

Virginia identified four point sources discharging to the impaired segments of Catoctin Creek; two of which are permitted to discharge fecal coliform. The two permitted point sources are active sewage treatment facilities that are currently discharging fecal coliform bacteria to the watershed. One is a water treatment plant which is not expected and is not permitted to discharge fecal coliform bacteria. The other is a single family residential sewage treatment plants which is covered by Virginia general permit VAG40. VADEQ reported that the general permit for the single family residential sewage treatment plant had expired and that the system was never installed in the unit. Therefore, this facility was not included in the TMDL.

The two facilities that are permitted to discharge fecal coliform bacteria in the impaired segments of Catoctin Creek are the Hamilton Sewage Treatment Plant and the Waterford Sewage Treatment Plant. They are located in the upper and lower segments of the South Fork of Catoctin Creek, respectively. The Hamilton facility is permitted to discharge fecal coliform at a concentration of 200 cfu/100 mL and has a flow of 0.16 million gallons per day (MGD). The Waterford facility is permitted to discharge at the same concentration but has a flow of 0.058 MGD. The WLA for these facilities was determined by multiplying their allowable concentration (200 cfu/100 mL) by their permitted flow by the number of days in a year (365).

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2 - Waste Load Allocations for the Impaired Segment of Catoctin Creek

Facility	Permit Number	Existing Load	Allocated Load
Hamilton STP	VA0020974	4.42E+11	4.42E+11
Waterford STP	VA0060500	1.60E+11	1.60E+11

<u>Load Allocations</u>

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the HSPF model to represent Catoctin Creek watershed. The HSPF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint loadings, and receiving water quality for conventional pollutants and toxicants[4]. HSPF uses precipitation data for continuous and storm event simulation to determine total fecal loading to the impaired segments of Catoctin Creek from forest, commercial and services, residential, cropland, livestock operations, farmstead, unimproved pasture, improved pasture, and potential livestock access land uses. The total land loading of fecal coliform is the result of the application

of manure and biosolids, direct deposition from cattle, other livestock and wildlife (geese, deer, etc.); the deposition of fecal coliform from failed septic systems and fecal coliform production from pets.

In addition, VADEQ recognizes the significant loading of fecal coliform from cattle in-stream, straight pipes, lateral flow from septic systems within 50 feet of the stream, and wildlife in-stream. These sources are not dependent on a transport mechanism to reach a surface waterbody, and therefore, can impact water quality during low and high flow events. Additional information on the sources of fecal coliform to the impaired segments of Catoctin Creek can be found in Section 3 of the fecal coliform TMDL for Catoctin Creek. Tables 3a through 3d document the land based nonpoint source loads and direct deposit nonpoint source loads. The land based nonpoint source loads are given in concentrations to the land segment not the stream. The loading from cattle in-stream was applied to the livestock access land use in the allocated loading column, causing an increase in loading to this land use.

Table 3a - LA for the upper South Fork of Catoctin Creek

Land Use	Existing Load	Allocated Load	Percent Reduction
Forest	1.36E+14	1.36E+14	0%
Commercial and Services	5.54E+12	5.54E+12	0%
Residential	2.28E+14	2.28E+14	0%
Cropland	5.10E+14	5.10E+14	0%
Livestock Operations	3.43E+13	3.43E+13	0%
Farmstead	1.80E+13	1.80E+13	0%
Unimproved Pasture	3.28E+13	3.28E+13	0%
Improved Pasture	1.39E+15	1.39E+15	0%
Livestock Access	5.98E+13	6.95E+13	-16%

[4] Supra, footnote 2.

Cattle In-stream	9.71E+12	0.0	100%
Wildlife In-stream	1.92E+12	1.72E+11	91%
Lateral Flow	1.23E+09	1.23E+09	0%
Straight Pipes	2.74E+11	0.0	100%

Table 3b - LA for the lower South Fork of Catoctin Creek

Land Use	Existing Load	Allocated Load	Percent Reduction
Forest	7.35E+13	7.35+E13	0%
Commercial and Services	1.32E+12	1.32E+12	0%
Residential	6.48E+13	6.48E+13	0%
Cropland	4.90E+12	4.90E+12	0%
Livestock Operations	0.00	0.00	0%
Farmstead	1.11E+13	1.11E+13	0%
Unimproved Pasture	2.75E+13	2.75E+13	0%
Improved Pasture	8.58E+14	8.58E+14	0%
Livestock Access	3.66E+13	4.08E+13	-11%
Cattle In-stream	4.28E+12	0.0	100%
Wildlife In-stream	1.38E+12	1.04E+12	25%
Lateral Flow	3.82E+08	3.82E+08	0%
Straight Pipes	9.52E+10	0.0	100%

Table 3c- LA for the North Fork of Catoctin Creek

Land Use	Existing Load	Allocated Load	Percent Reduction
Forest	2.14E+14	2.14E+14	0%
Commercial and Services	3.41E+10	3.41E+10	0%
Residential	6.89E+13	6.89E+13	0%
Cropland	1.32E+15	1.32E+15	0%

Livestock Operations	0.0	0.0	0%
Farmstead	1.02E+13	1.02E+13	0%
Unimproved Pasture	3.70E+13	3.70E+13	0%
Improved Pasture	1.96E+15	1.96E+15	0%
Livestock Access	8.36E+13	1.00E+14	-20%
Cattle In-stream	1.68E+13	0.0	100%
Wildlife In-stream	2.50E+12	1.75E+11	93%
Lateral Flow	5.17E+08	5.17E+08	0%
Straight Pipes	1.12E+11	0.0	100%

Table 3d - LA for Catoctin Creek

Land Use	Existing Load	Allocated Load	Percent Reduction
Forest	4.45E+14	4.45E+14	0%
Commercial and Services	2.53E+11	2.53E+11	0%
Residential	1.85E+14	1.85E+14	0%
Cropland	5.05E+13	5.05E+13	0%
Livestock Operations	1.09E+10	1.09E+10	0%
Farmstead	2.36E+13	2.36E+13	0%
Unimproved Pasture	9.14E+13	9.14E+13	0%
Improved Pasture	3.02E+15	3.02E+15	0%
Livestock Access	1.15E+14	1.32E+14	-14%
Cattle In-stream	1.70E+13	0.0	100%
Wildlife In-stream	6.65E+12	9.98E+11	85%
Lateral Flow	1.74E+09	1.74E+09	0%
Straight Pipes	2.25E+11	0.0	100%

3) The TMDL considers the impacts of background pollution.

A background concentration was set by determining the wildlife loading to each land segment.

4) The TMDL considers critical environmental conditions.

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Catoctin Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[5]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. These critical conditions ensure that water quality standards will be met for other than worst case scenarios.

The sources of bacteria for these stream segments were a mixture of dry and wet weather driven sources. Therefore, the critical condition for the impaired segments of Catoctin Creek was represented as a typical hydrologic year. Since these segments were modeled to attain the geometric mean standard and base and low flow events occurred far more often then wet weather events, it was essential that the standard be maintained during these periods. Therefore, base flow conditions were the more critical period.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis effectively considered seasonal environmental variations. The model also accounted for the seasonal variation in loading. Fecal coliform loads changed for many of the sources depending on the time of the year. For example, cattle spent more time in the stream in the summer and animals were confined for longer periods of time in the winter.

6) The TMDLs include a margin of safety.

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[5]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL.

Virginia includes an explicit margin of safety by establishing the TMDL target water quality concentration for fecal coliform at 190 cfu/ 100mL, which is more stringent than Virginia's water quality standard of 200 cfu/100 mL. This would be considered an explicit 5% MOS.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program. Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.

The TMDL in its current form is designed to meet the applicable water quality standards. However, due to the wildlife issue that was previously mentioned, the Commonwealth believes that it may be appropriate to modify its current standards to address the problems associated with wildlife loadings. The Commonwealth is investigating possibly changing the use of these waters or having a natural condition amendment added to their standards.

8) The TMDLs have been subject to public participation.

Three public meetings were held to discuss TMDL development on the impaired segments of Catoctin Creek. All of the public meetings were public noticed in the *Virginia Register* and opened to at least a thirty-day comment period. The first meeting was held on October 23, 2001 in Lovettsville, VA. Ten people attended this meeting on the TMDL. Approximately 30 people attended the second meeting which was held in Hillsboro, VA on January 23, 2002. One written comment letter was received during the associated public comment period. The third public meeting was held on March 26, 2002 in Hillsboro, VA and 14 people attended the third public meeting. No written comments were received during the public comment period.